tory difficulties by keeping the anesthetizing drugs below the thoracic levels, should materially increase the safety of the patient.

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CARBON MONOXID POISONING*

By ROBERT T. LEGGE, M. D.
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DISCUSSION *by Morton R. Gibbons, M. D., San Francisco; William C. Hassler, M. D., San Francisco; Alex. M. Lesem, M. D., San Diego.*

CARBON MONOXID is the most widespread and important toxic agent of modern civilization, preëminently greater than classic plumbism, on account of its multitude of applications in industry. The significance of this hazard warrants an intense interest of the medical profession and the general public on account of the incidence of morbidity and mortality from the use of illuminating or heating gas for domestic purposes and the deadliness of exhausts from automobiles and other gas engines.

SOURCES OF MODERN DANGER

The very general use of automobiles and other gasoline-burning engines whose exhausts contain 7 per cent of carbon monoxid, and the consequent vitiation of atmosphere in garages, traffic tunnels, and congested thoroughfares, has given public health and industrial hygienists much concern. A recent average of 141 tests made by United States Public Health chemists in city streets at peak hours of traffic showed a contamination of 0.8 in 10,000 parts of air, while in 102 tests made in twenty-seven garages taken in fourteen different cities the average carbon monoxid content was 2.1 parts in 10,000. One of the greatest dangers to life is encountered in warming up an engine in the small, closed garage; a hazardous act that should be given universal publicity. Coroner reports annually record the increased fatalities as a result of idling a running motor in a garage. It has been estimated that a motor will discharge two feet of carbon monoxid every minute, so that in twenty minutes the atmosphere would be concentrated enough to kill a dog by asphyxiation.

From an industrial hygienist's view, the amount of carbon monoxid should not be more than one part in 10,000 parts of air where workers are employed. Every industrial physician and employer should be familiar with the approximate amount of carbon monoxid eliminated in the special processes of manufacturing at his plant. Whenever carbon-containing fuels are burned, such as coal, gasoline, oil or charcoal, without sufficient oxygen completely to oxidize the fuel, carbon monoxid is liberated. The various industrial processes, whether accomplished by furnaces of all kinds, explosions, blasting, gas works, heating, and oil-distilling plants, furnish many cases of poisoning from this colorless, tasteless, and odorless gas.

DIAGNOSIS

The diagnosis of carbon monoxid poisoning rests mainly on a history of possible exposure and the presence of carbon monoxid in the blood either before or after death. At autopsy, when evidence is observed of the preservation of the body from decomposition—the cherry-red color of the organs, tissues, and blood, and the fluidity of the latter—there is no question of the diagnosis, CO poisoning. It is important to note that the greatest changes in the tissues found at postmortem are those of extensive fatty degeneration of the heart, kidney, walls of blood vessels, and other tissues. Minute hemorrhages throughout the brain are common. This one poisonous feature of carbon monoxid, *i. e.* the rapid fatty degeneration of organs, may have some bearing on the increase in and explanation of the mortality statistics of heart disease.

Every industrial precaution to detect carbon monoxid should be studied and observed. Normally the gas is odorless, except when mixed with other gases as in the case of common illuminating gas, which contains 30 per cent CO. In mines canary birds or mice are used to detect dangerous atmospheres. These animals are twenty times more susceptible than man. A bird will show signs of distress when exposed for one hour to 0.1 per cent of CO.

The Bureau of Mines has developed a detector which will give immediate positive results with carbon monoxid in the air in concentration of .07 per cent or more. This is known as hoolamite or the activated iodin pentiodid indicator, perfected by Teague, and a proven instrument of great value in mine rescue work and in testing plants where this hazard prevails.

Sayers and Yant of the United States Bureau of Mines have developed a quick and accurate method for the quantitative determination of carbon monoxid in the blood and air by the pyrotannic acid test. It is of great value in making a positive diagnosis in suspected cases. Normal diluted blood that has been shaken with an equal volume of one per cent tannic acid produces a gray suspension; whereas blood containing carbon monoxid remains carmin red. A color index is made by treating dilutions of varying strengths of blood with tannic acid. A sample of unknown blood prepared in similar strength could be readily matched with these corresponding standards, and the percentage of carbon monoxid ascertained.

The symptoms of carbon monoxid may be divided into two stages. In the first stage there is a feeling of tightness across the forehead, dizziness, frontal and basal headache, smarting of the eyes, lack of proper muscular coördination, nau-

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sea or vomiting, with increased pulse and respiration. In concentrated atmospheres, the victim, due to rapid poisoning, may develop syncope at once, without any of the early symptoms. Exposure of a pregnant woman to carbon monoxid may cause the death of the fetus in utero, with subsequent miscarriage.

In the second stage the symptoms are characterized by loss of muscular control, especially of the sphincters, loss of reflexes, low blood pressure, coma usually with intermittent convulsions, shallow and irregular breathing, and finally cessation of respiration. In general the predominant symptoms depend upon the percentage of blood saturation. It has been shown that strenuous exercise in a high temperature and humidity cause more rapid combination of carbon monoxid with hemoglobin than when the subject remains at rest.

Physiologically the tissues of the body derive their oxygen from the oxyhemoglobin of the red blood cells. Carbon monoxid has an affinity for hemoglobin three hundred times greater than oxygen. It is for this reason that when the oxyhemoglobin molecule becomes dissociated from carbon monoxid the tissues no longer are nourished by oxygen and asphyxiation results. The damage that is done to the brain and other organs is directly the result of oxygen privation. When 60 to 80 per cent of the red cells are saturated, death usually ensues. The sequelae of a severe gassing of CO are pneumonia, blindness, neuroses, muscular irritability, and mental instability that may be permanent. Secondary effects are sometimes delayed for days after apparent recovery, and these may be permanent as in cases of deranged mental and nerve conditions. When coma is present after twenty-four hours the prognosis is unfavorable.

RESCUE METHODS

The first important duty in mines, gas works, blast furnaces, domestic and other industrial gas asphyxiations, is rescue. Only oxygen helmets and not ordinary army gas masks should be used by the rescuers to transport the victims to a safe place in the open. Mine rescue teams and firemen are regularly trained for such emergencies. Immediate artificial respiration by the prone pressure method must be instituted, and the inhalation of oxygen given continuously until evidence of asphyxiation is relieved.

Recently, after the researches of Henderson and Haggard of Yale, it was observed that carbon dioxid is a powerful respiratory stimulant tending, when mixed with oxygen, in the proportion of 1 in 20, to induce deep, full, breathing which rapidly displaces the deadly carbon monoxid from the blood. The mixed gases are administered by means of an inhalator, an instrument of great superiority. This piece of apparatus should constitute a necessary piece of equipment in every hospital, emergency station, ambulance, fire department, coal mine, and industrial plant where carbon monoxid is a hazard. Another new remedy for carbon monoxid poisoning has recently been developed by German chemists, and is now reputed as being used with extraordinary success. This drug is known as lobelin, an alkaloid from an American plant known as lobelia inflata. It is administered intravenously as a powerful respiratory stimulant producing rapid results, and is said to be successful after oxygen has failed. This valuable drug now obtainable in ampoule form should be in every physician's emergency outfit.

As the successful recovery from carbon monoxid poison depends upon the early elimination of the poison from the blood, it is therefore absolutely imperative to increase the rate and depth of the respiration by the administration of pure oxygen or the 5 per cent carbon dioxid oxygen mixture, which mixture hastens the elimination of carbon monoxid five times faster than does normal air.

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DISCUSSION

MORTON R. GIBBONS, M. D. (350 Post Street, San Francisco).—Doctor Legge's paper is so complete that it is hardly pertinent to discuss it from a technical standpoint.

CO poisoning *is* a growing menace, with the increasing possibilities appearing in industry.

Education would seem to be the essential thing now, education of the people to the dangers. However, this phase of the subject presents conflicting thoughts. Every newspaper in the land advertises the danger of the gas stove and the closed garage door. The frequency of accidents from the closed garage door-open automobile exhaust complex suggests the possibility that some cases verge upon the gas-stove variety of suicide.

That physicians are alive to the possibilities is shown by the fact that more than fifty cases were reported to the Industrial Accident Commission in the last year as CO poisoning, and about one-half that number presented no vestige of such poisoning.

CO poisoning has been the claim in death cases in several far-fetched instances.

In one such case the deceased was seized with some form of heart failure, yet the claim was made of CO poisoning. He was cranking the motor of a lawn mower in the open air. There was no evidence produced that the motor ever started.

Doctor Legge's paper is timely. More education is necessary. It is necessary even to educate the friends of the would-be victim, so that the victim may be forestalled.

WILLIAM C. HASSLER, M. D. (1085 Mission Street, San Francisco).—Doctor Legge's paper has scientifically presented to us the dangers that come from the generation of carbon monoxid in industry. To the administrator of public health the generation of this gas has a special significance, particularly when it comes to the matter of its generation in the sweat shops, factories, and manufacturing plants, where the amount of carbon monoxid liberated into the air is insufficient to cause immediate poisoning, yet the quantities, because of poorly ventilated apparatus as well as poorly ventilated work rooms, creates a condition that gradually destroys the red blood cells and brings about those

degenerative changes in heart, kidneys and walls of the blood vessels, of which Doctor Legge speaks, lowering efficiency and resistance and undoubtedly causing a form of chronic invalidism which may be one of the basic causes for the high death rate from heart and kidney diseases among the workers in these places.

Carbon monoxid is a serious factor in the housing of people in large cities. Cooking, eating and sleeping in one room with unventilated gas stoves has been the cause of thirty-one deaths out of one hundred and eighteen credited to carbon monoxid poisoning in San Francisco from January to December of 1927. Eighty-seven were attributed to suicide, but again no positive evidence exists that any of these deaths were suicide. The defective rubber tubing connecting gas plates and gas jets, as well as the lack of proper outlets to flues or the open air from gas stoves, cannot be wholly guarded against.

It behooves every health officer to enforce rigidly the housing laws and compel those erecting apartments and transforming the old residences into one and two-room places for housing of families, to see that every kitchen is supplied with a flue to carry off the product of combustion from the gas stoves and to eliminate altogether the gas plate with rubber tube connection.

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ALEX M. LESEM, M. D. (739 Fourth Street, San Diego).—In discussing this paper I wish to state that during the year 1925 our local community experienced a number of cases of carbon monoxid poisoning which were classified as distinctly separate from suicidal attempts.

I believe that the American Gas Association through experimentation in its laboratory has established the fact that carbon monoxid poisoning caused by gas appliances burning natural gas, artificial gas, or mixed gas is due to incomplete combustion. Gas appliances which are designed to burn natural gas do not satisfactorily burn artificial or mixed gases, so a good deal depends upon the intelligent installation of the proper gas appliances.

During the first six months of 1925 forty-three cases of carbon monoxid poisoning which resulted in death were reported to the State Board of Health. Many cases resulted from moving appliances from localities where natural gas was burned to other cities where artificial gas was employed. Another factor proved to be the purchase of worn-out appliances from second-hand stores, together with faulty installation and without municipal inspection.

The third factor is the installation of gas appliances which have never been inspected or approved by the American Gas Association; which are sold for much less money than approved appliances; and which are taken home and installed by the purchaser without proper ventilation.

I wish to limit my discussion to gas appliances responsible for incomplete combustion. I believe that the solution for this particular cause of accidents lies in the education of the community along the lines of proper use and installation of gas appliances.

I believe that legislative bodies in every community should assume responsibility for prevention of such accidents and should require that all piping and gas appliances be installed under the most rigid and competent inspection.

I believe that all physicians interested in the preventive phase of carbon monoxid poisoning should be highly in favor of a state-wide legislation which would educate the consumer and prevent haphazard installations of these appliances which have proved so dangerous to human lives.

SOME OBSERVATIONS ON THE ANEMIAS*

By ROBERT POLLOCK, M. D.
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DISCUSSION *by Rachel L. Ash, M. D., San Francisco; J. M. McCullough, M. D., Crockett; Willard J. Stone, M. D., Pasadena.*

THAT anemia of the severer grades is seemingly on the increase in this country, is evidenced by the increase of activity in combating it. Official vital statistics do not accurately record the deaths from anemia, partly because the disease with which the anemia is associated usually gets the credit for the death, and partly because of the unfortunate nomenclature in the anemias.

Any marked deviation from normal blood is sooner or later registered on all the functions and tissues of the body; hence anemia of marked degree is always of vital interest to the clinician. The vast amount of research done on anemia during the past year or two warrants a critical analysis of this material. I am attempting to bring forward only such points as may be termed controversial in order by discussion to help toward a better understanding. I find here a subject wherein etiology, diagnosis, treatment and prognosis all furnish abundant material for speculation and diversity of opinion. However, scientific truth is an ever changing, constantly shifting entity, and the last word has never been said on any subject.

CLASSIFICATION

An adequate working classification of the anemias is the following:

1. Anemias due to hemorrhage: ulcer, hemorrhoids, nephritis, urologic conditions, cancer and casualty.
2. Anemias due to hemolysis from toxins, known or unknown, such as malaria, sepsis, chemical bodies, hemolytic jaundice, some cases of pernicious anemia.
3. Anemias due to disease or defective function of the blood making tissues, such as the aplastic anemias, some cases of pernicious anemia.

So-called pernicious anemia is probably most often due to hemolysis from unknown toxins, although some of these cases are probably true aplastic anemias. The aplastic cases are as a rule rapidly fatal and occur before middle age.

Usually when hemolysis is taking place we have an increase of the urobilinogen in the urine and a yellowing of the skin.

Most of the discussion of the past year has centered about the so-called pernicious anemia, chiefly on account of the renewal of interest in its dietetic treatment. Here is an anemia showing a marked degree of hemolysis, accompanied by evidence of increased regeneration of cells, such as the appearance of nucleated red cells and megaloblasts. The red cells show many irregularities in form with a comparative increase in their size over those in other anemias as evidenced by their cell volume. This is accountable for the high color index in this anemia. To rely upon the color index in the matter of differential diagnosis between a

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